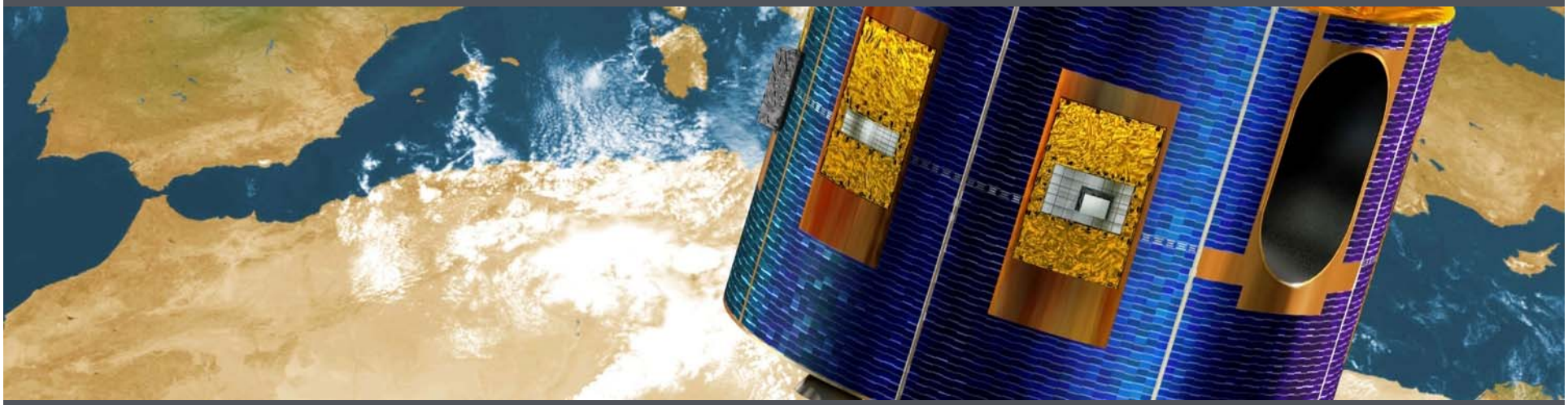
TAMSAT: LONG-TERM RAINFALL MONITORING ACROSS AFRICA



Ross Maidment, Emily Black, Matthew Young and Dagmawi Asfaw
TAMSAT, University of Reading

Helen Greatrex
IRI, Columbia University

13th EUMETSAT User Forum in Africa
24th-28th September, 2018

TAMSAT

The **TAMSAT** (**T**ropical **A**pplications of **M**eteorology using **SAT**ellite and ground-based observations) group, based in Reading (UK), have provided locally calibrated **satellite-based rainfall estimates** for Africa since the 1980s.

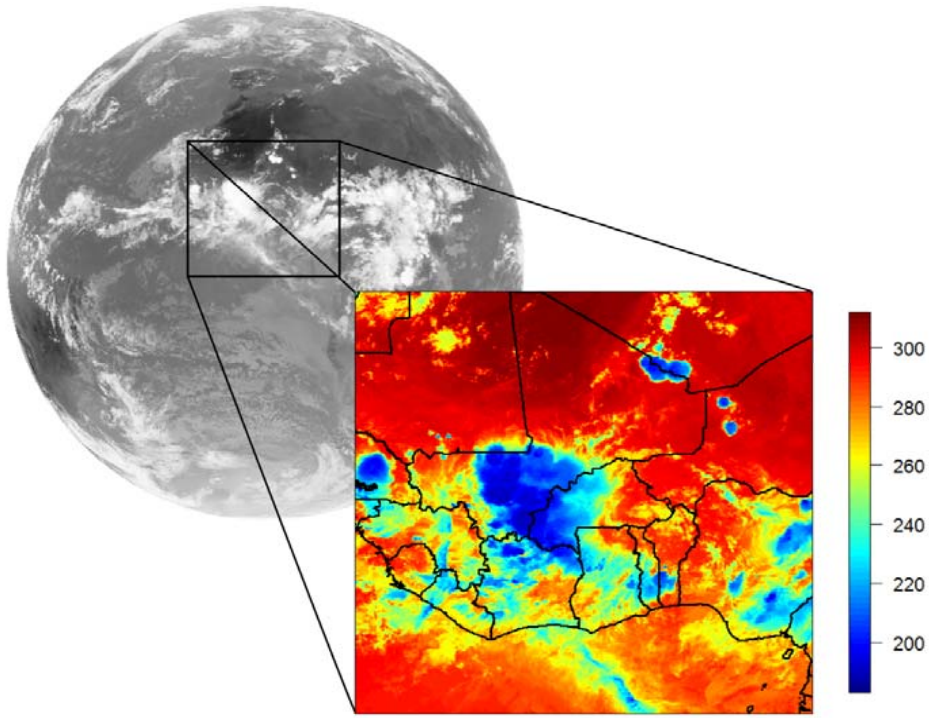
Such data are vital for many applications, in particular rainfall monitoring and assessment of long-term rainfall change across Africa.

TAMSAT have co-operated with numerous African meteorological services over the years, building up strong relationships, through both regional workshops and students taking MSc and PhD courses at Reading's Meteorology Department.

In this presentation, we present an overview of TAMSAT rainfall products and other areas of development within the group and the wider Earth Observation Division.

TAMSAT Estimation Method

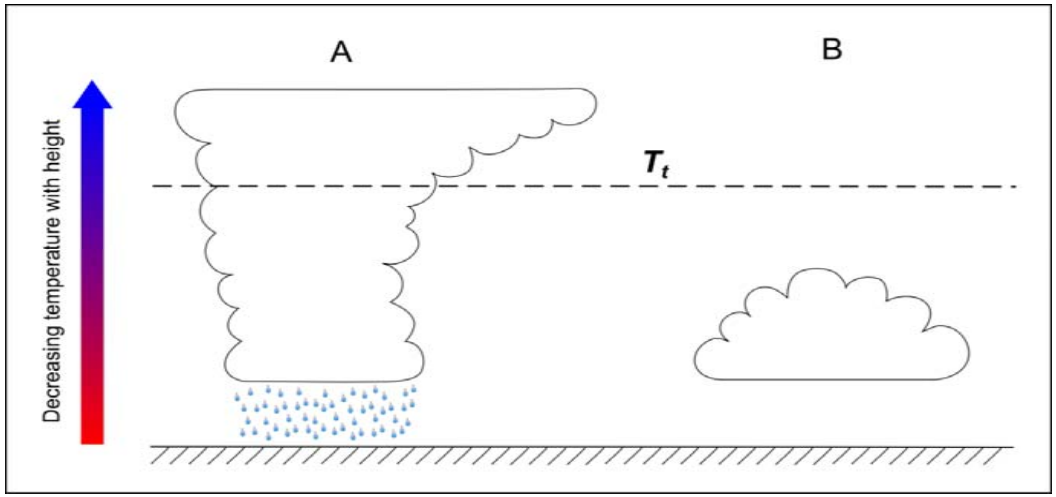
The **TAMSAT** rainfall estimation approach is based on Meteosat Thermal Infra-Red imagery to identify precipitating cumulonimbus clouds (deep convection)



TAMSAT Estimation Method

TAMSAT rainfall estimates are based on two inputs:

- **Meteosat thermal infrared imagery**, used to create cold cloud duration (CCD) maps
- **Rain gauges**, used to calibrate the CCD



Main assumptions

Case A: Clouds with tops colder than the optimum temperature threshold (Tt) are assumed to be raining

Case B: Clouds with tops warmer than Tt are assumed not to be raining

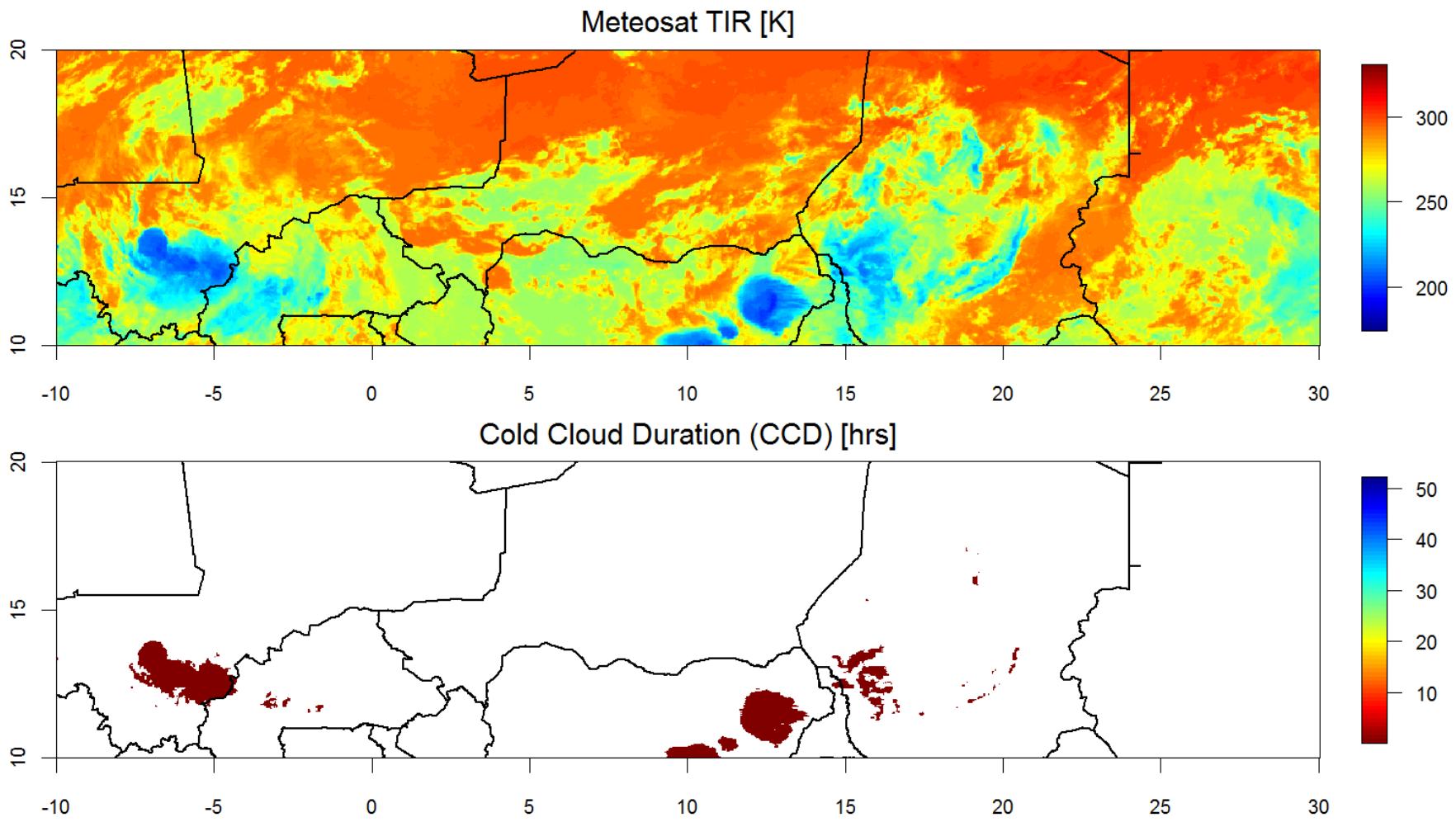
CCD maps are calculated based on the total duration the cloud top temperature is colder than a prescribed temperature threshold (T_t)

Rainfall is assumed to be a linear function of CCD: $Rain = a0 + a1 * CCD$

Using historical data, T_t, a_0 and a_1 are all estimated during the calibration process

Cold Cloud Duration (CCD)

Date: 20070801 Time: 0600 Threshold: -50C



Link between convective rainfall and IR satellite imagery

Example: 12th Nov 2016 over South Africa

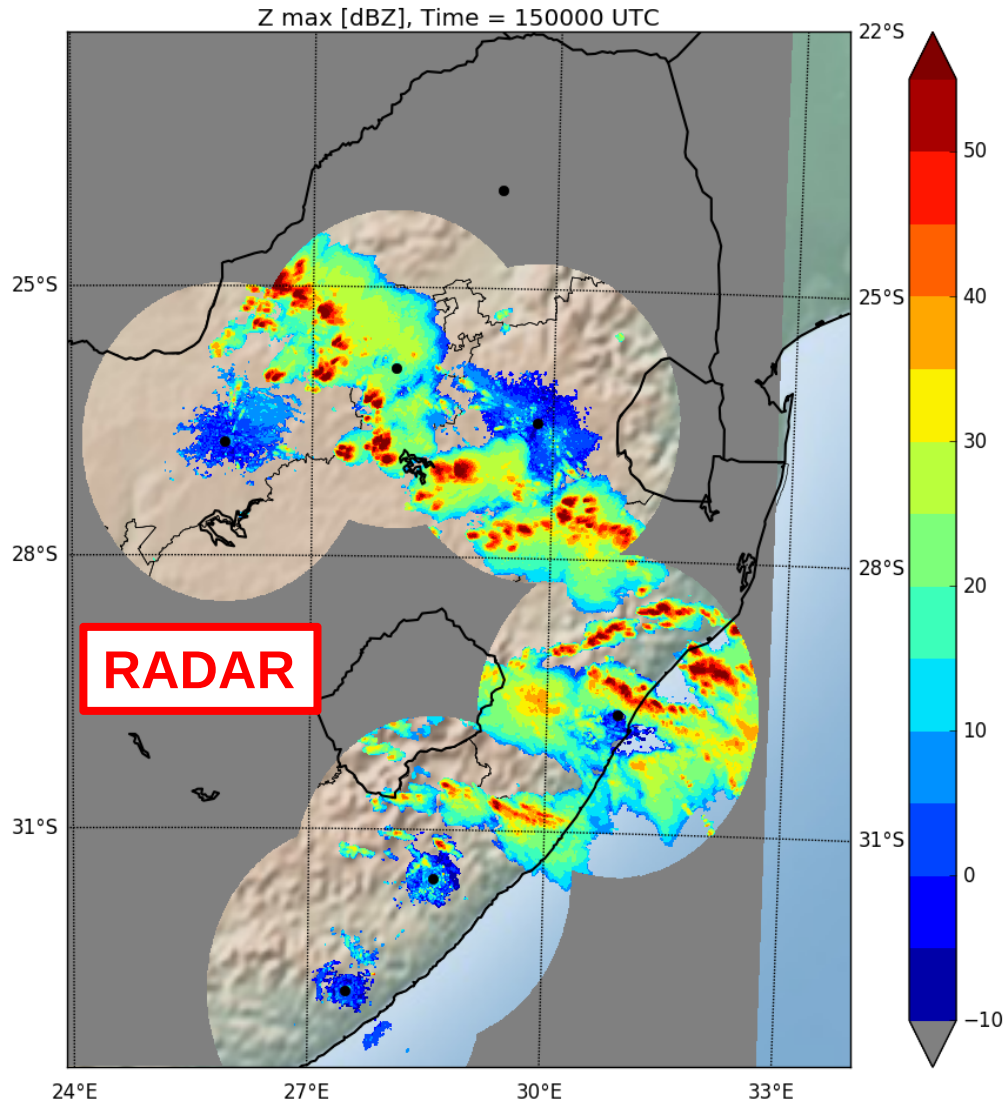


Figure courtesy of Dr Will Keat (University of Reading)

Thanks to SAWS for providing the radar data

Link between convective rainfall and IR satellite imagery

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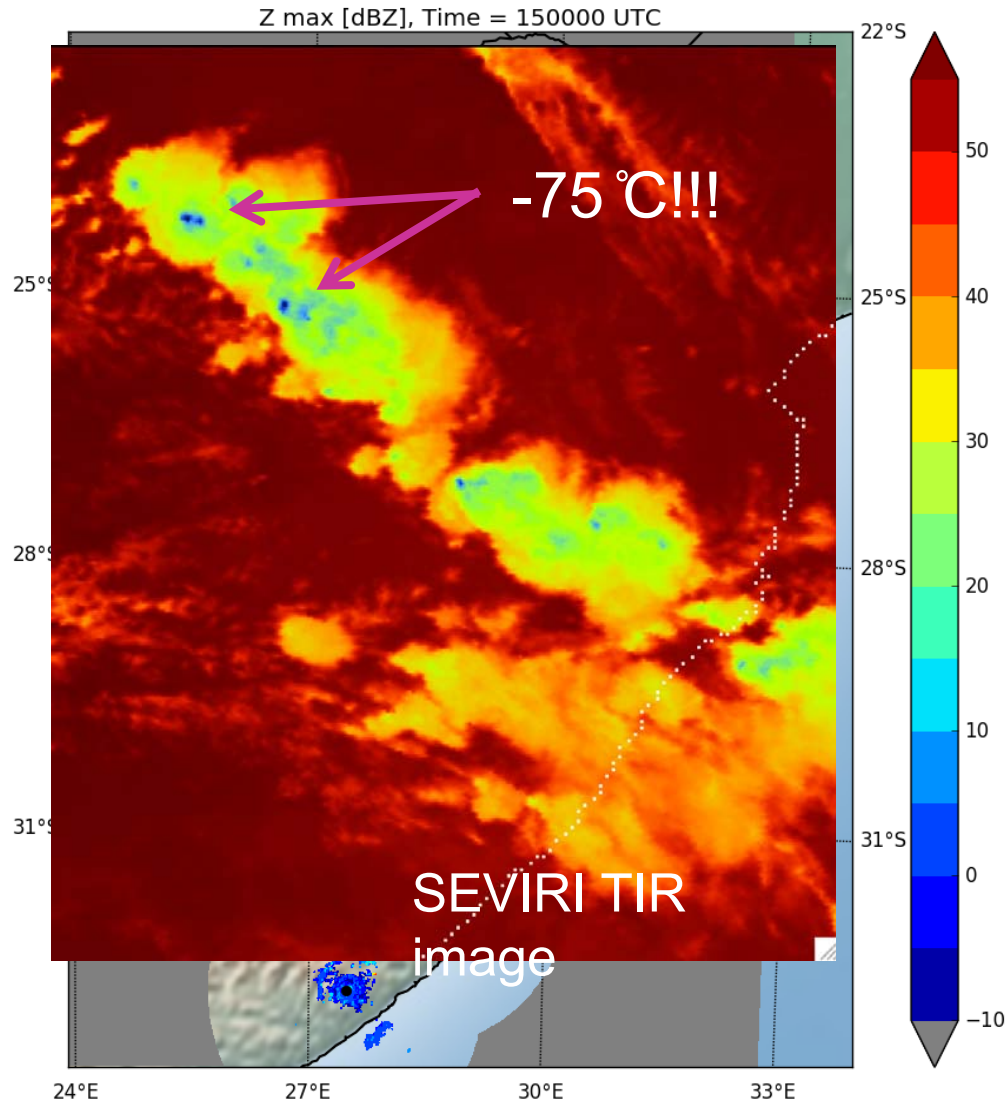


Figure courtesy of Dr Will Keat (University of Reading)

Thanks to SAWS for providing the radar data

TAMSAT Version 3.0
Operational since Jan 2017

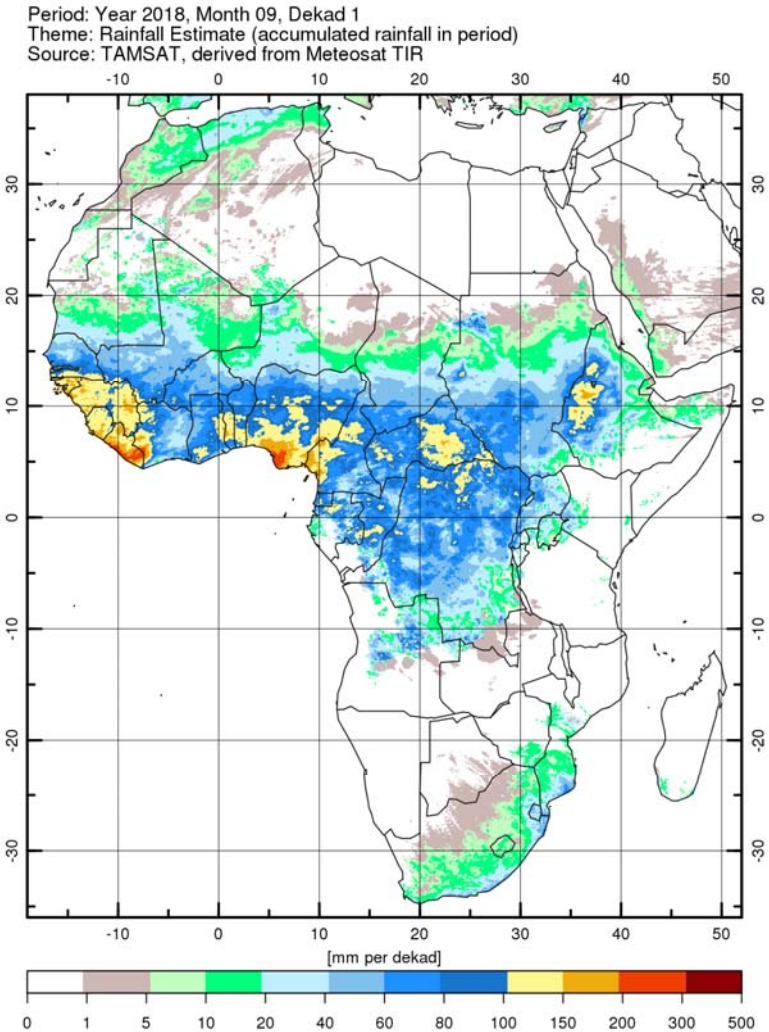
Products

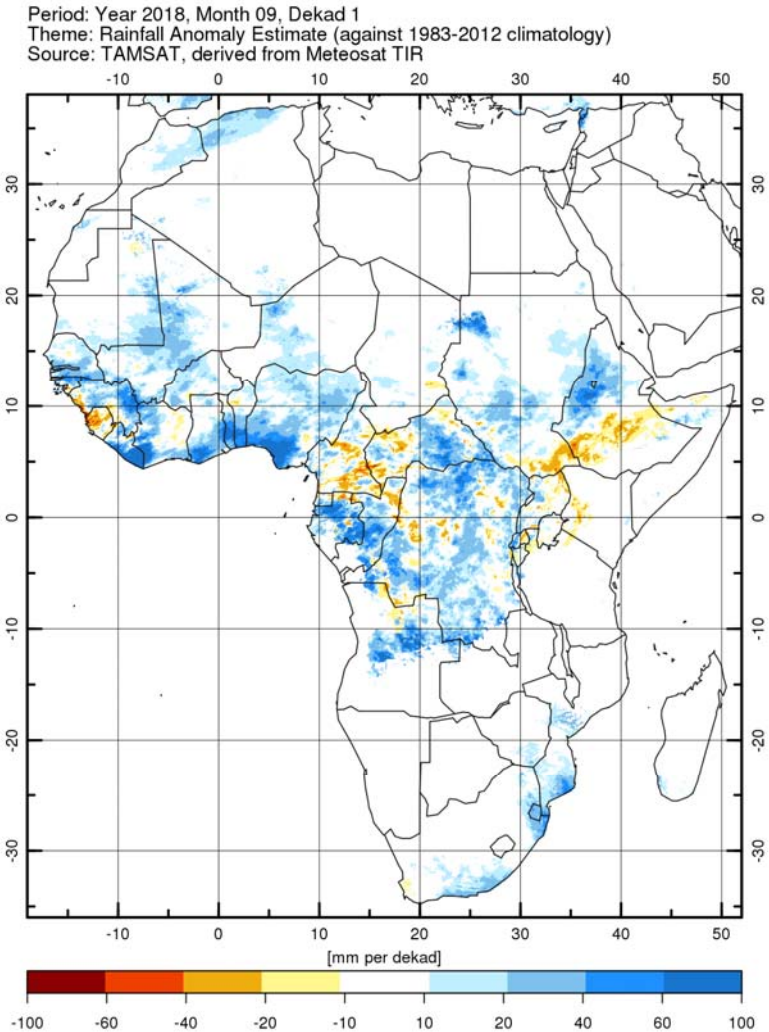
Primary product	Pentadal Estimates	
Derived products	Daily Estimates *(disaggregated, based on daily CCD)*	Dekadal Estimates Monthly Estimates Seasonal Estimates *(aggregated)*

Summary

- Africa-wide estimates at 4 km resolution
- 1983 to present, 2-day latency
- Available from www.tamsat.org.uk (also available on the **FEWS Net early warning explorer**, **IRI Data Library** and soon to be on **EUMETCast**)

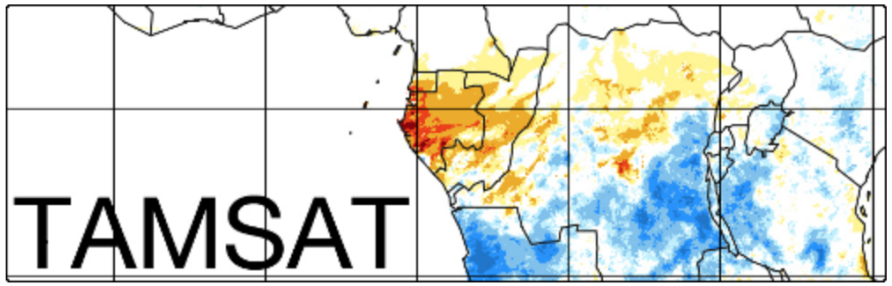
TAMSAT Estimation method:
1st dekad September 2018 (1st-10th rainfall total)





TAMSAT Data Subsetting Tool

Users can extract data for any region/time period



Data Subset Service

Dataset	TAMSAT v3 Daily
Timeseries at a point (CSV)	●
Timeseries over a region (CSV)	○
Regional data (NetCDF)	○
Latitude	0
Longitude	0
Start Date:	1/1983
End Date:	2/2018
Email address	
Job/Group Reference ⓘ	tamsat-subset

Submit Job

Will be live on the TAMSAT website from early November!

TAMSAT Data
Strengths and weaknesses

Strengths	• Longevity (+35 years)
	• Available at the daily time-step with 2-day latency
	• Temporally consistent
	• Skillful estimates
	• Suitable in many application, e.g.:
	  o drought monitoring
	  o famine early warning
	  o trend analysis
	  o risk assessment
	  o index insurance

Weaknesses	• Underestimates intense rainfall events • Can miss warm rain events (coastal/orographic) • Persistent high level cirrus leads to overestimation

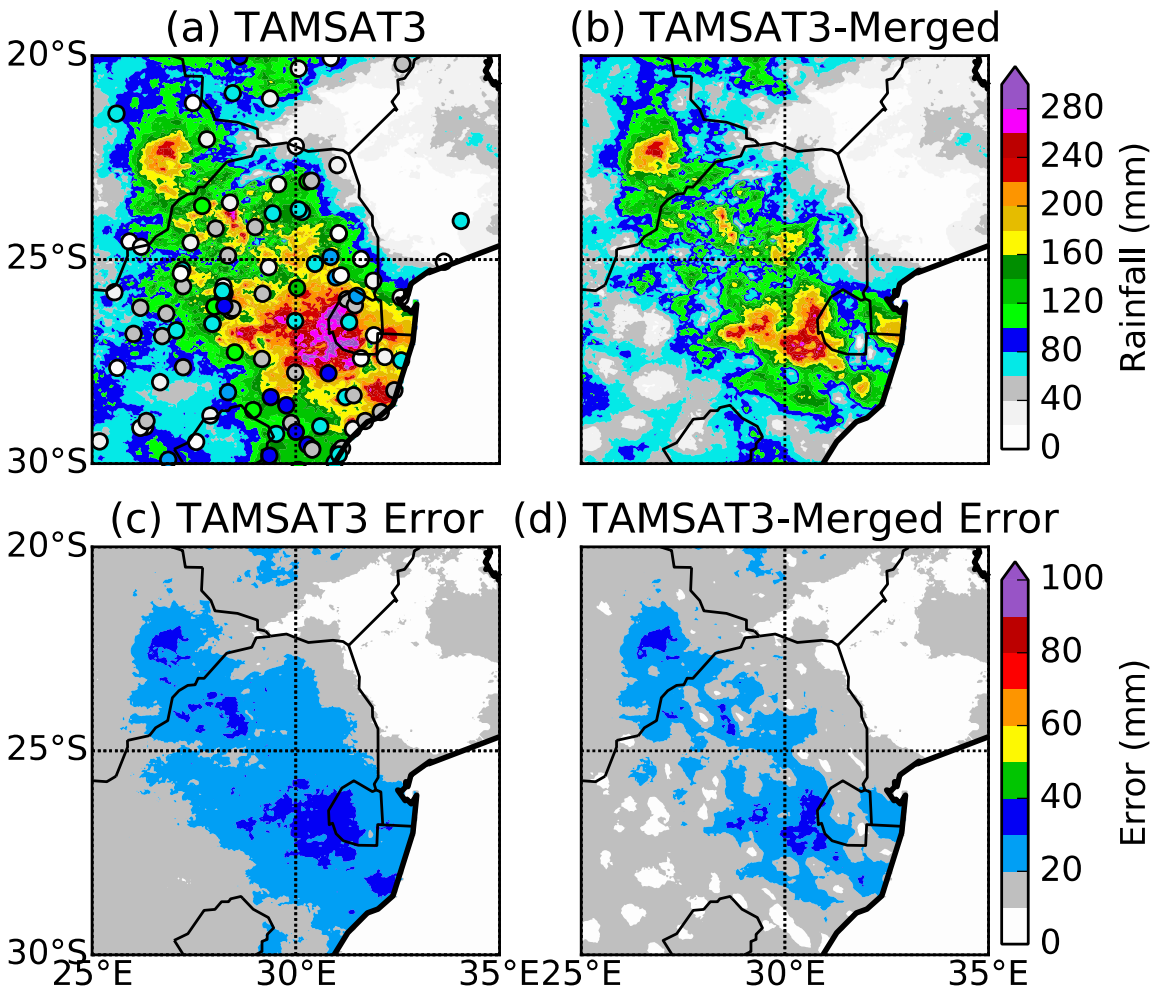
Other developments [1]: merged satellite-gauge estimates

Improve rainfall intensities by using auxiliary information

TAMSAT estimates will tend to **underestimate extreme rainfall events** due to the lack of information in CCD on rainfall intensity.

In TAMSAT, we have developed a novel method to **incorporate contemporaneous gauge information** to improve rainfall intensities, especially extreme events.

Aim is to have an operational merged product by 2020.



Other developments [2]: TAMSAT-ALERT
Managing the risk of agricultural drought in Africa

In Reading, in conjunction with Ghana Meteorological Agency, NCAS-Climate and NCEO, TAMSAT have developed a novel framework for agricultural decision support.

TAMSAT-ALERT (the **TAMSAT A**gricu**L**tural **E**a**R**ly warning sys**T**em) is an operational system providing early warning of meteorological risk to agriculture.

TAMSAT-ALERT combines information on **land surface properties**, **forecasts** and **historical weather** with a well-established impact models to quantitatively assess the likelihood of adverse weather-related outcomes

See Matthew Young's talk on Thursday afternoon in Session 6 (5 pm)

Summary of TAMSAT v3.0 rainfall product

Characteristic	TAMSAT
Inputs	TIR satellite imagery, gauge
Spatial Resolution	4km
Spatial Coverage	Africa
Temporal Resolution	Daily, 5-day, 10-day, monthly, seasonal
Start date	Jan 1983
Latency	2 days
Strengths	• Longevity (+35 years) • Temporally consistent • Daily timestep and short latency • Good for drought monitoring, famine early warning, index insurance

Looking to the future:

- Web-based data extraction tool ready in the next few months
- A complete rainfall dataset (1983-present) by Spring 2019
- An operational Africa-wide satellite-gauge merged product by 2020

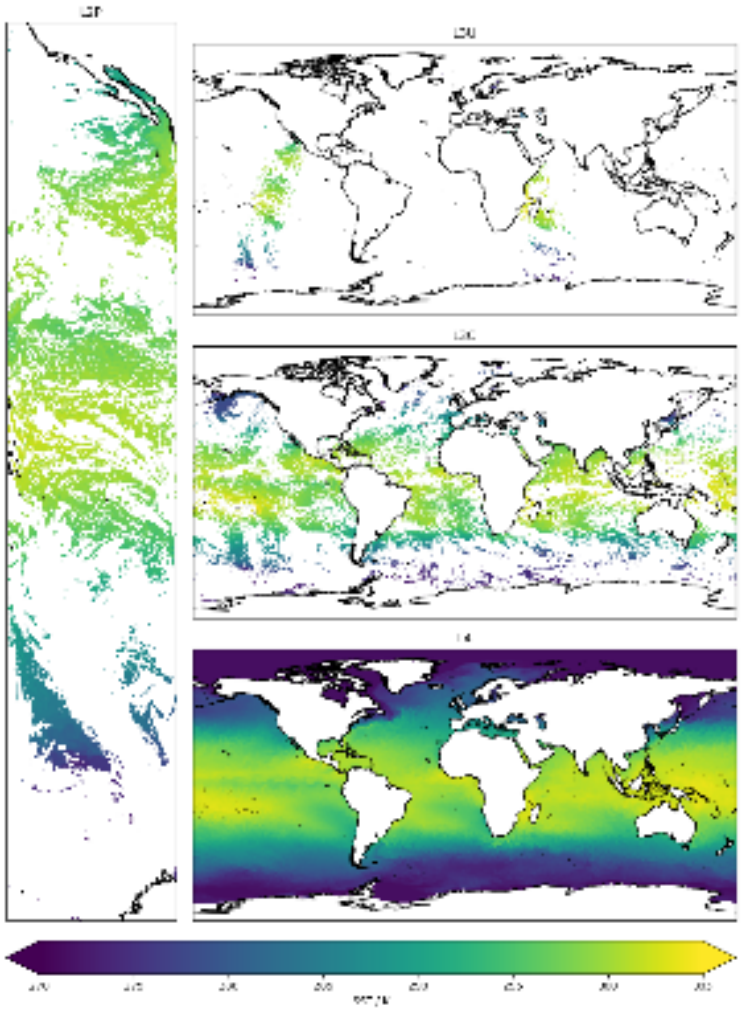
Other University of Reading satellite products:
Sea Surface Temperature
Climate Change Initiative/Copernicus Climate Change Service

ESA Climate Change Initiative (CCI)

- Climate Data Record (CDR) of SST
- Daily product, 0.05 degrees
- Sensors: ATSR, AVHRR
- 1980s to end-2016
- Expected release March 2019

Copernicus Climate Change Service (C3S)

- Interim Climate Data Record (ICDR) of SST (extends SST-CCI CDR)
- Currently monthly updates ~1 year latency
- Will become short delay (daily update, < 1 week latency)
- Sensors: SLSTR, AVHRR



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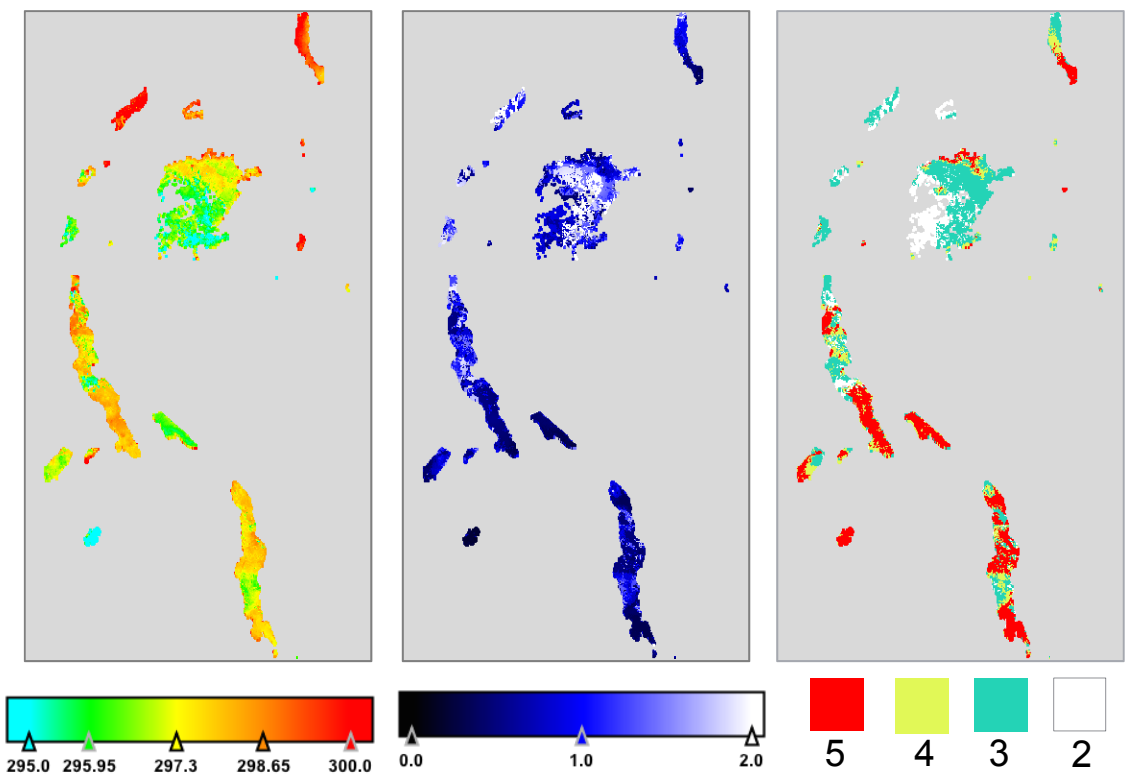
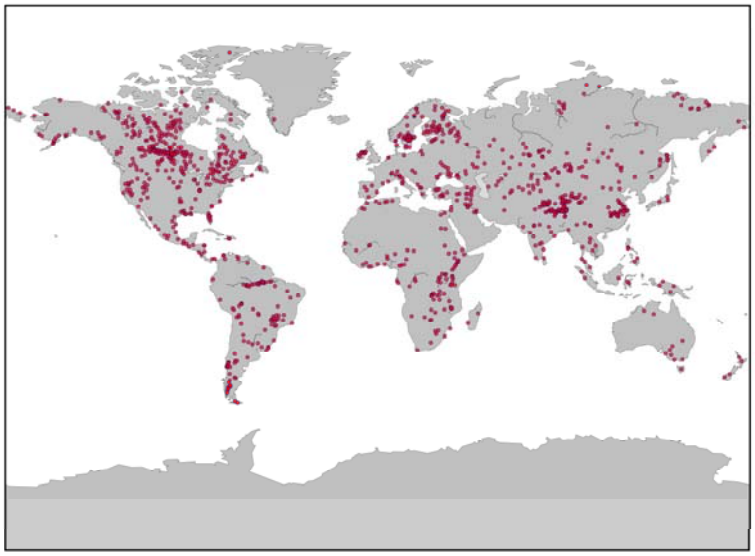
Other University of Reading satellite products:
Lake Surface Water Temperature
CGLOPS (Copernicus Global Land Service – Water)

Start	Time step	Latency	Spatial RES	Instrument	N of lakes
10/04/2018 (16/11/2016)	10 days	3-4 days	1/120 degrees	SLSTR on Sentinel3a	1000 globally

LSWT (K) LSWT UNC (K) Quality levels





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Final Remarks

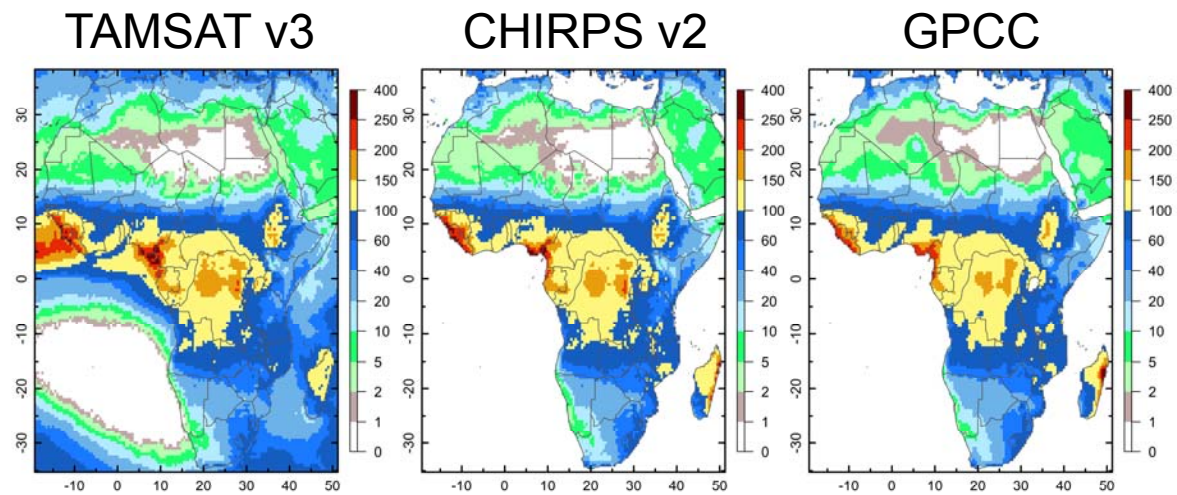
TAMSAT are keen to collaborate with Met Services or other organisations on the aspect of satellite rainfall estimation

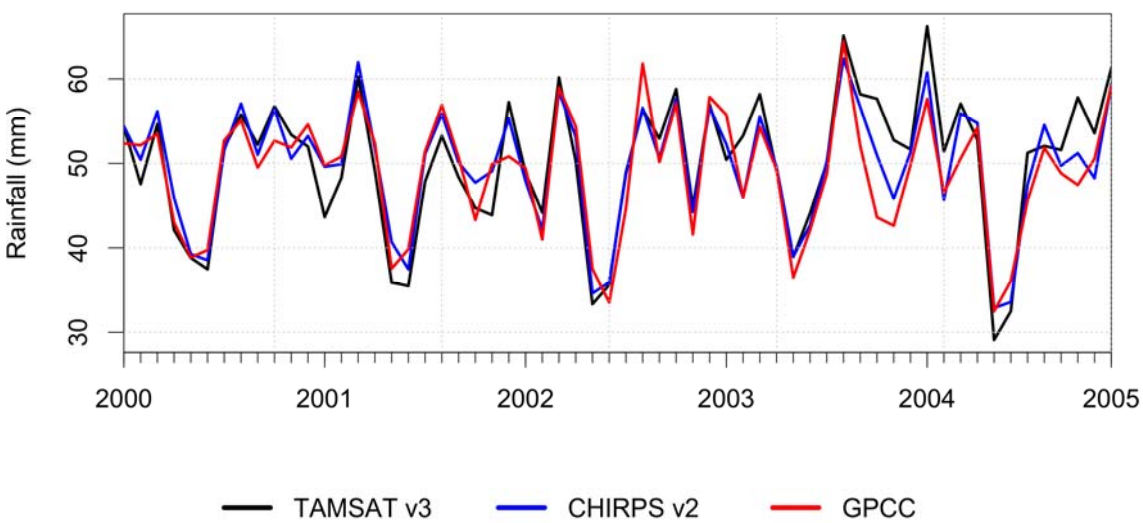
If you are interested in **TAMSAT v3**, **TAMSAT research products**, or any **other products** mentioned, please get in touch!

Very happy to offer advice on both data access, usage and validation methodologies

TAMSAT skill

TAMSAT v3.0 is consistent with other datasets





V3.0 validation papers:

Maidment et al., (2017) Nature Scientific Data

Dinku et al., (2018) QJRS

Ayehu et al., (2018) AMT